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**INFLUENCE OF BLACK LOCUST  
(*Robinia pseudoacacia* L.) SHELTERBELTS  
ON THE CONTENT AND FRACTIONAL COMPOSITION  
OF HUMUS IN ARABLE SOIL DEVELOPED FROM LOESS**

**WPLYW ZADRZEWIEŃ ROBINII AKACJOWEJ (*Robinia pseudoacacia* L.)  
NA ZAWARTOŚĆ I SKŁAD FRAKCYJNY PRÓCHNICY  
GLEBY UPRAWNEJ WYTWORZONEJ Z LESSU**

**Abstract:** The objective of the study was to evaluate the influence of black locust afforestation adjacent to arable loess soil on its fractional humus composition. Fractional humus composition was assessed according to Boratynski and Wilk. The content of total humus and humus fractions decreased with the distance from black locust afforestation. It was observed the dependance of distance from trees on decrease of humus fractions strictly connected with mineral phase (IV fraction) and humines. Therefore their higher concentrations in the zones adjacent to the trees was an evidence of a beneficial role of black locust on soil organic matter composition. Amount of movable humus fractions content (I fraction) was lower in the field zones close to the trees (15.3 %) than in those 12 m from the afforestation (19.1 %). Average values of the ratio HAC/FAC was a bit higher in the zone 0–12 m away from the trees (1.03) in comparison with the more distant ones (0.91).

**Key words:** *Robinia pseudoacacia*, black locust, humus

Black locust (*Robinia pseudoacacia* L.) due to its small edaphic requirements is used for planting on all types of wasteland, primarily in dry and poor soils [1]. *Robinia* plantings are frequently used for reclamation of former opencast mines and in the areas destroyed by improper human activity [2].

On agricultural lands of the Proszowice Plateau and Miechow Upland black locust shelterbelts are quite frequent, the trees were planted there among others to reinforce the loess ravines and at the same time for high quality wood fuel [3].

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Robinia lives in a symbiosis with *Baciullus radicola* nodule bacteria and bacteria of *Rhizobium* species. Therefore, its influence on increasing nitrogen content in soils is a commonly known fact [4–6]. On the other hand there is no literature data concerning the effect of black locust shelterbelts on the quantity and quality of humus in ploughlands [7].

The research aimed to determine the effect of black locust shelterbelts adjoining a ploughland on fractional composition of humus in arable soil developed from loess.

## Material and methods

Soil samples were collected from the 0–20 cm layer of a microplot situated in Krolewice village at the Proszowice Plateau, marked out on an arable field adjoining black locust shelterbelts. The trees forming the shelterbelts are between 20 and 30 years old. The shelterbelts are formed exclusively from robinia trees, the undergrowth is poor, mainly composed of herbaceous plants counted by some to *Chelidonio-Robinetum* alliance, which is associated with allelopathic effect of robinia trees on the other plant species [8].

The 20 m × 24 m microplot was divided into 12 zones (2 m wide) at growing distance from the trees and 5 microplots with area of 2 m × 4 m were separated in each zone. Samples representing each zone were taken from the microplots. In 60 samples collected in this way organic carbon content was assessed using Tiurin method in Oleksynowa modification and converted into organic substance content. In collective samples representing each zone, humus fractional composition was determined using Boratynski and Wilk method. The results of humus content assessments were elaborated geostatistically using Surfer 8.0 Programme. The data were subjected to statistical analysis using post-hoc Tukey test in Statistica 7.0 programme.

## Results and discussion

The soil cover of the analyzed field consists of brown soils (*Eutric Cambisol*) developed from loess. The analyzed brown soil which represented the soil cover of the researched area was characterized by clay silt granulation. Acid reaction (pH = 4.72) was assessed in the humus horizon. The highest contents of total nitrogen and organic carbon were registered in the arable-humus horizon Ap (respectively 0.17 % and 1.40 %).

The highest content of humus (over 2.80 %) was determined in the soil samples taken at the distance of 12 m from the robinia shelterbelts (Fig. 1, Table 1). The exception was the 2–4 m zone, where 2.75 % humus was assessed. Humus content was diminishing visibly with the distance from the shelterbelts and in the farthest zone (22–24 m) did not exceed 2.45 %. On the basis of Tukey test statistically significant differences in humus contents at the significance level 0.05 were registered between the 0–8 m and 8–24 m zones.

It evidences a humus forming role of black locust in the first place affecting the arable field zones close to the shelterbelts. These values confirm previous results of

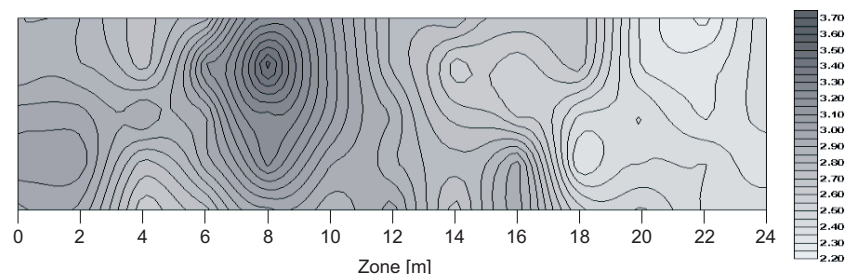


Fig. 1. Humus content [%] in particular zones

research conducted in China stating the identical role of robinia, particularly on sandy soils [9]. The influence of shelterbelts on humus content in soil was apparent in the zones situated up to 10 m from the trees, which is a distance comparable with their height.

Table 1

Significance level of differences (calculated on the base of the Tukey test)  
between average humus content in soils of particular zones (differences are significant if  $p < 0.05$ )

Zone [m]	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24
Average humus content, %	2.93	2.75	2.92	3.23	3.00	2.86	2.70	2.73	2.54	2.43	2.36	2.42
0-2		0.57	1.00	0.02	1.00	1.00	0.18	0.42	< 0.01	< 0.01	< 0.01	< 0.01
2-4	0.57		0.66	< 0.01	0.11	0.97	1.00	1.00	0.32	0.01	< 0.01	< 0.01
4-6	1.00	0.66		0.02	0.99	1.00	0.24	0.51	< 0.01	< 0.01	< 0.01	< 0.01
6-8	0.02	< 0.01	0.02		0.23	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
8-10	1.00	0.11	0.99	0.23		0.82	0.02	0.06	< 0.01	< 0.01	< 0.01	< 0.01
10-12	1.00	0.97	1.00	< 0.01	0.82		0.67	0.91	0.01	< 0.01	< 0.01	< 0.01
12-14	0.18	1.00	0.24	< 0.01	0.02	0.67		1.00	0.76	0.07	< 0.01	0.05
14-16	0.42	1.00	0.51	< 0.01	0.06	0.91	1.00		0.45	0.02	< 0.01	0.02
16-18	< 0.01	0.32	< 0.01	< 0.01	< 0.01	0.01	0.76	0.45		0.95	0.51	0.93
18-20	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.07	0.02	0.95		1.00	1.00
20-22	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.51	1.00		1.00
22-24	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.05	0.02	0.93	1.00	1.00	

The contents of isolated humus compounds was declining with the distance from the shelterbelts: from 1.62 % C (0-2 m zone) to 1.02 % C (22-24 m zone) (Fig. 2). A negative effect of the distance from false acacia on the content of humus substances most strongly bound to mineral soil fraction (humines) was found, as well as humus substances separated in IV extraction (using  $0.1 \text{ mol} \cdot \text{dm}^{-3}$  NaOH solution) determined as strongly bound to mineral soil phase [10]. Higher contents of these fractions in the

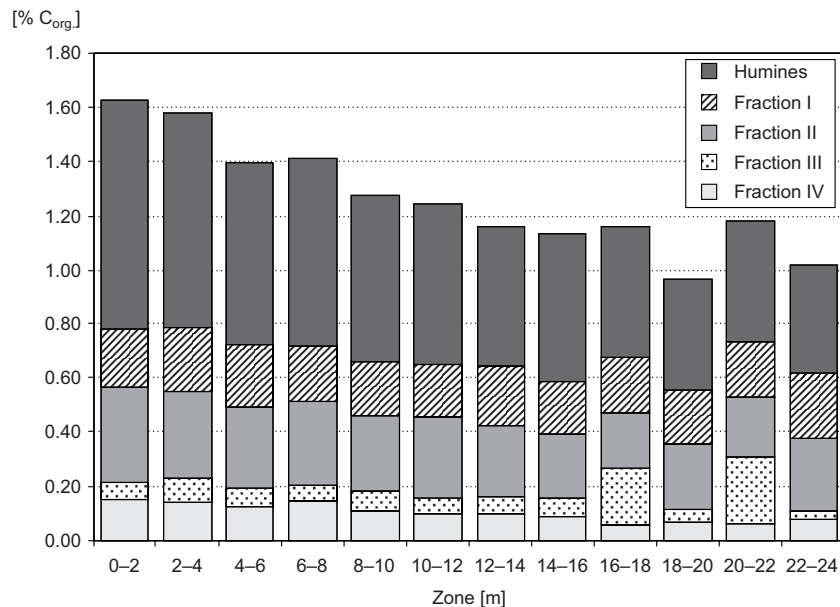


Fig. 2. Humus compounds extracted in particular extractions [% of C<sub>org.</sub>]

zones adjoining the trees testifies a positive effect of acacia on humus composition. Percentage of mobile humus bonds (fraction I) was lower in the zones up to 12 m from the acacia (on average 15.3 %) in comparison with the 12–24 m zones (on average 19.1 %).

Table 2

HAC/FAC ratio of humus compounds in particular extractions

Zone [m]	Extraction I	Extraction II	Extraction IV	Total
0–2	0.82	1.20	1.35	1.09
2–4	0.77	1.14	1.96	1.11
4–6	0.41	1.18	1.42	0.86
6–8	0.85	1.15	1.24	1.06
8–10	0.70	1.24	1.21	1.01
10–12	0.89	0.99	1.72	1.05
12–14	0.54	1.04	1.10	0.82
14–16	0.64	1.14	1.12	0.92
16–18	0.68	1.20	1.06	0.92
18–20	0.59	1.03	1.23	0.85
20–22	0.73	1.65	0.91	1.09
22–24	0.58	1.03	1.16	0.83

The greatest amounts of leaves, branches and pods fall in the area of the microplot closest to the shelterbelts. Fallen black locust leaves revealing a low C:N ratio are fast decomposed and provide an additional source of nitrogen in the soils [11]. Nitrogen originating from organic matter decomposition and from the process of atmospheric N assimilation by root bacteria may be easily transformed into humus substances with highest process of humification [7]. It was corroborated by the obtained mean value of humic to fulvic acids ratio (Table 2). HAC/FAC ratio computed for the zones distanced up to 12 m from the shelterbelts was higher than the one calculated for the zones > 12 m far from the trees (respectively 1.03 and 0.91).

## Conclusions

1. The highest content of humus was assessed in the soil samples collected at the distance of 12 m from black locust trees.
2. A negative effect of the distance from the acacia on the humin and humus substances content strictly connected with soil mineral phase was determined.
3. A percentage of mobile humus bonds was lower in the zones 0–12 m far from black locust in comparison with 12–24 m zones.
4. HAC/FAC ratio computed for the zones distanced up to 12 m from the shelterbelts was higher than calculated for the zones > 12 m far from the trees.

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**Abstrakt:** Celem badań było określenie wpływu zadrzewień robinii akacjowej sąsiadujących z użytkiem ornym na skład frakcyjny próchnicy lessowej gleby uprawnej. Skład frakcyjny próchnicy określono, stosując metodę Boratyńskiego i Wilka. Zawartość próchnicy i wydzielonych połączeń próchnicznych malała wraz z odległością od zadrzewień. Stwierdzono ujemny wpływ odległości od robinii na zawartość humin oraz substancji próchnicznych ściśle związanych z mineralną fazą gleby (frakcja IV). Wyższa zawartość tych frakcji w strefach sąsiadujących z drzewami jest dowodem korzystnego oddziaływania robinii na skład próchnicy. Średnia wartość stosunku CKH/CKF obliczona dla stref oddalonych do 12 m od zadrzewień była większa niż obliczona dla stref bardziej oddalonych od drzew (odpowiednio 1,03 i 0,91).

**Słowa kluczowe:** *Robinia pseudoacacia*, grochodrzew, próchnica